African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0159

Certified Reference Material

Copper cobalt oxide ore
Tenke Fungurume, DRC

Certificate of Analysis

Recommended Concentrations and Limits[1.]
(at two Standard Deviations)

Certified Concentrations[2.]

Co F	1704	±	112	ppm
Co M/ICP	1675	±	97	ppm
Co P	1641	±	109	ppm
Co XRF	1604	±	153	ppm
Cu F	1.031	±	0.093	%
Cu M/ICP	1.043	±	0.038	%
Cu P	1.025	±	0.080	%
Cu XRF	1.002	±	0.062	%
Specific Gravity	2.72	±	0.06	

1. *Manufacturers recommended limits for use of the material as control samples, based on two standard deviations, calculated using "Between Laboratory" statistics for treatment of the data for trivial, non-trivial and technically invalid results. See sections 1, 9 and 12.*
2. *There is additional certified major element data presented on p2 and uncertified trace element data presented as an appendix.*

Major Element
Recommended Concentrations and Limits
(at two Standard Deviations)

Certified Concentrations

Al_2O_3	1.11	±	0.04	%
CaO	0.56	±	0.22	%
Fe_2O_3	1.84	±	0.06	%
K_2O	0.22	±	0.01	%
MgO	0.54	±	0.06	%
MnO	0.030	±	0.002	%
P_2O_5	0.42	±	0.02	%
SiO_2	92.49	±	0.80	%

Provisional Concentrations

Cr_2O_3	0.087	±	0.012	%
TiO_2	0.070	±	0.012	%
LOI	0.96	±	0.16	%

Informational Mean

Na_2O	0.057	%

1. Intended Use: AMIS0159 can be used to check analysis of samples of copper cobalt ores with a similar grade and matrix.

It is a matrix matched Certified Reference Material, fit for use as control samples in routine assay laboratory quality control when inserted within runs of samples and measured in parallel to the unknown. Its purpose is to monitor inter-laboratory or instrument bias and within lab precision. It can be used, indirectly, to establish the traceability of results to an SI system of units.

The recommended concentrations and limits for this material are property values based on a measurement campaign (round robin) and reflect consensus results from the laboratories that participated in the round robin.

Slight variations in analytical procedures between laboratories will reflect as slight biases to the recommended concentrations (see 19). Good laboratories will report results within the two standard deviation levels with a failure rate of <10 %.

The material can also be used for method development and for the calibration of equipment.

2. Origin of Material: AMIS0159 is a commissioned CRM made from run-of-mine oxide Cobalt-Copper ore from the Tenke Fungurume (Tenke) mine operated by Freeport- McMoRan Copper & Gold Inc. The mine is situated in Katanga Province of the Democratic Republic of Congo 175km northwest of the regional capital Lubumbashi.

3. Mineral and Chemical Composition: The Tenke-Fungurume deposits are sedimentary copper deposits located in the Lufilian arc, an 800 km fold belt formed between the Angolan Plate to the southeast and Congo Plate to the northwest during the late Neoproterozic approximately 650 to 600 million years before present (Ma). Copper mineralization at Tenke-Fungurume is stratabound and generally restricted to two dolomitic shale horizons (RSF and SDB respectively) each ranging in thickness from 5 to 15 m, separated by 20 m of cellular silicified dolomite (RSC).

The main economic minerals present at Tenke and Fungurume are malachite, chrysocolla, bornite, and hetrogenite; the primary copper and cobalt mineralogy is predominately chalcocite (Cu2S), digenite (Cu9S5) bornite (Cu5FeS4), and carrollite (CuCo2S4); however oxidation has resulted in widespread alteration producing malachite (Cu2CO3(OH)2), pseudomalachite (Cu5(PO4)2(OH)4), chrysocolla (hydrated copper silicate) and heterogenite (Co3+O(OH)).

The primary copper-cobalt mineral associations are homogeneous in both mineralized zones and any variations are due to the effect of oxidation and supergene enrichment. Consequently the mineral assemblages can be grouped into three main categories dependent upon the degree of alteration – oxide, mixed and sulfide zone. Dolomite and quartz are the main gangue minerals present. Dolomite or dolomitic rocks make up the bulk of the host strata. Weathering of the host rocks is normally depth related, intensity decreasing with increasing depth, producing hydrated iron oxides and silica at the expense of dolomite, which is leached and removed.

For a detailed description please refer to the Technical Report prepared for Tenke Mining Corp by GRD Minproc Limited available at:

http://www.lundinmining.com/i/pdf/TenkeFungurumeFeasibilityStudy.pdf

4. Appearance: The material is a very fine Pinkish Grey powder (Corstor colour chart –5YR 8/2).

5. Handling instructions: The material is packaged in Laboratory Packs and Explorer Packs that must be shaken or otherwise agitated before use. Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

6. Method of Preparation: The material was crushed, dry-milled and air-classified to <54um. Wet sieve parti**c**le size analysis of random samples confirmed the material was 98.5% <54um. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and consensus test results were carried out by an independent statistician.

7. Methods of Analysis requested:

1. Co,Cu. Fusion AAS or ICP-OES.
2. Multi-acid digest multi-element scan - (to include Co, Cu). ICP-OES or ICP-MS.
3. Aqua regia digest – Co, Cu. ICP-OES or ICP-MS.
4. Pressed pellet multi-element scan - (to include Co, Cu). XRF.
5. Majors (Al2O3, CaO, Cr2O3, Fe2O3, K2O, MgO, MnO, Na2O, SiO2, TiO2. LOI.) XRF fusion.
6. SG. Gas pycnometer.

Six laboratories with the capability were additionally requested to complete the additional analyses. This was too few laboratories for a formal certification, so this uncertified data is presented in the appendix.

1 SOP 06. Quick Leach Test
2 Acid soluble Cu & Co.
3 Total Cu, Co, Ca, Mg & Mn.

8. Information requested:

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. Results for individual analyses to be reported.
4. All results for base metals to be reported in ppm.

5. Report all QC data, to include replicates, blanks and certified reference materials used.

9. Method of Certification: Twenty three laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Twenty laboratories reported results in time for certification of the economic elements. Fifteen of these laboratories reported results for the major elements.

Final limits were calculated after first determining if all data was compatible within a spread normally expected for similar analytical methods done by reputable laboratories. Data from any one laboratory was then removed from further calculations when the mean of all analyses from that laboratory failed a "t test" of the global means of the other laboratories. The means and standard deviations were then re-calculated using all remaining data. Any analysis that fell outside of the new two standard deviations was removed from the ensuing data base. The mean and standard deviations were again calculated using the remaining data.

The "between-laboratory" standard deviation is used in the calculation to eliminate technically and statistically invalid data. Upper and lower limits are based on the standard deviation of the remaining data, which reflect individual analyses and can be used to monitor accuracy in routine laboratory quality control. This is different to limits based on standard deviations derived from grouped set of analyses (see 12), which provide important measures for precision and trueness, but which are less useful for routine QC.

Standards with an RSD of near or less than 5 % are termed "Certified", RSD's of between near 5 % and 15 % are termed "Provisional", and RSD's over 15 % are termed "Informational".

10. Participating Laboratories: (Not in same order as in the table of assays):

1. Alex Stewart International Corporation Zambia
2. ALS Chemex Laboratory Group Brisbane Australia
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group Lima (Peru)
5. ALS Chemex Laboratory Group Perth WA
6. ALS Chemex Laboratory Group Vancouver CA
7. Anglo Research (Crown Campus)
8. FMI Technology Center
9. Genalysis Laboratory Services (South Africa) Pty
10. Genalysis Laboratory Services WA
11. Intertek Utama Services (Indonesia)
12. OMAC Laboratories Limited (Ireland)
13. Set Point Laboratories (Isando) SA
14. SGS Australia Pty Ltd (Newburn) WA
15. SGS Mineral Services Callao (Peru)
16. SGS Mineral Services Lakefield (Canada)
17. SGS South Africa (Pty) Ltd - Booysens
18. SGS Toronto (Canada)
19. Skyline Assayers and Labs
20. Ultra Trace (Pty) Ltd WA

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 is set out below. A proficiency report has been sent to the managers of the participating laboratories. Additional digital data from this round robin is available on request.

Lab	Co	Co	Co	Co	Cu	Cu	Cu	Cu	Al2O3	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O	P2O5	SiO2	TiO2	LOI	SG
Code	F	M/ICP	P	XRF	F	M/ICP	P	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF		pyc
	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	
A		1790	1530			11200			1.14	0.56	0.10	1.85	0.22	0.54	0.03	0.04	0.42	92.25	0.08	0.80	
A		1710	1520			10500			1.12	0.55	0.10	1.83	0.22	0.54	0.03	0.05	0.42	92.40	0.08	0.90	
A		1710	1500			10600			1.13	0.56	0.10	1.85	0.22	0.54	0.03	0.04	0.42	92.47	0.07	0.90	
A		1740	1510			10800			1.12	0.55	0.09	1.85	0.22	0.51	0.03	0.03	0.41	92.41	0.07	0.80	
A		1730	1500			10800			1.13	0.55	0.10	1.84	0.22	0.53	0.03	0.02	0.42	92.25	0.07	0.90	
A		1750	1540			10900			1.12	0.55	0.09	1.85	0.22	0.52	0.03	0.04	0.42	92.64	0.08	0.90	
A		1700	1510			10800			1.12	0.55	0.09	1.86	0.23	0.53	0.03	0.04	0.42	92.51	0.08	0.90	
A		1730	1520			10600			1.11	0.55	0.09	1.84	0.22	0.52	0.03	0.03	0.42	92.28	0.08	0.90	

Assay data (cont)

Lab Code	Co F	Co M/ICP	Co P	Co XRF	Cu F	Cu M/ICP	Cu P	Cu XRF	Al2O3 XRF	CaO XRF	Cr2O3 XRF	Fe2O3 XRF	K2O XRF	MgO XRF	MnO XRF	Na2O XRF	P2O5 XRF	SiO2 XRF	TiO2 XRF	LOI	SG pyc
	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	
B	1722		1613	1659	1659		9774	10146	1.12	0.55	0.09	1.86	0.22	0.52	0.03	0.05	0.45	92.61	0.07		2.64
B	1639		1629	1668	1668		10271	10437	1.08	0.56	0.09	1.92	0.22	0.54	0.04	0.06	0.44	93.20	0.07		2.72
B	1629		1612	1642	1642		9804	10141	1.11	0.55	0.09	1.89	0.23	0.55	0.03	0.06	0.42	92.72	0.07		2.69
B	1542		1638	1639	1639		10450	10340	1.11	0.55	0.09	1.86	0.23	0.52	0.03	0.06	0.43	92.10	0.07		2.65
B	1704		1642	1688	1688		10496	10651	1.07	0.56	0.09	1.89	0.22	0.52	0.04	0.06	0.43	93.76	0.07		2.64
B	1668		1634	1630	1630		10071	10360	1.04	0.56	0.10	1.91	0.22	0.55	0.03	0.07	0.43	92.93	0.07		2.71
B	1587		1617	1639	1639		10147	10185	1.09	0.55	0.09	1.86	0.23	0.52	0.03	0.07	0.43	92.69	0.07		2.69
B	1648		1658	1688	1688		10256	10331	1.13	0.54	0.09	1.86	0.22	0.53	0.04	0.07	0.43	92.35	0.07		2.66
C	1740	1700		1690	1690	10600		10300	1.12	0.57	0.09	1.84	0.23	0.53	0.03	0.06		92.55	0.07	0.94	2.71
C	1720	1720		1680	1680	10300		10000	1.13	0.56	0.09	1.84	0.23	0.53	0.03	0.06		92.60	0.07	0.90	2.73
C	1740	1700		1670	1670	10300		10200	1.11	0.56	0.09	1.83	0.23	0.52	0.03	0.05		92.45	0.07	0.89	2.70
C	1720	1730		1690	1690	10500		10200	1.11	0.57	0.09	1.83	0.22	0.53	0.03	0.05		92.49	0.07	0.96	2.71
C	1760	1730		1700	1700	10600		10200	1.12	0.56	0.09	1.84	0.23	0.53	0.03	0.06		92.54	0.08	0.92	2.72
C	1700	1710		1710	1710	10600		10300	1.11	0.56	0.09	1.83	0.23	0.53	0.03	0.06		92.44	0.08	0.94	2.71
C	1720	1710		1670	1670	10300		10000	1.12	0.56	0.09	1.84	0.22	0.54	0.03	0.06		92.40	0.08	0.92	2.72
C	1740	1720		1690	1690	10400		10100	1.12	0.56	0.09	1.84	0.23	0.53	0.03	0.05		92.60	0.08	0.88	2.72
D	1700	1800	1500	1490	1490		9600	10000		0.50	0.08	1.84	0.21	0.57	0.03	0.07	0.42	91.98	0.06	1.05	2.72
D	1700	1700	1500	1457	1457		9600	10000		0.50	0.08	1.83	0.23	0.56	0.03	0.08	0.42	92.39	0.06	1.06	2.72
D	1700	1700	1500	1524	1524		9500	10000		0.52	0.08	1.83	0.21	0.58	0.03	0.07	0.43	92.15	0.05	1.06	2.71
D	1700	1700	1500	1522	1522		9500	10000		0.51	0.08	1.85	0.21	0.59	0.03	0.07	0.42	92.27	0.05	1.07	2.72
D	1700	1700	1500	1460	1460		9700	10000		0.52	0.08	1.82	0.21	0.57	0.03	0.08	0.42	92.68	0.05	1.05	2.73
D	1700	1800	1500	1438	1438		9800	10000		0.51	0.08	1.83	0.20	0.57	0.03	0.07	0.42	92.27	0.09	1.06	2.71
D	1700	1700	1500	1389	1389		9300	10000		0.51	0.08	1.81	0.21	0.55	0.03	0.07	0.42	92.17	0.06	1.04	2.72
D	1700	1700	1500	1455	1455		9500	10000		0.51	0.08	1.81	0.21	0.57	0.03	0.08	0.42	92.03	0.06	1.05	2.73
E	1770	1720				10300			1.07	0.57	0.09	1.88	0.23	0.53	0.03	0.08		92.60	0.08	0.89	
E	1690	1670				10300			1.06	0.56	0.09	1.88	0.23	0.51	0.03	0.07		92.60	0.06	0.92	
E	1770	1700				10300			1.08	0.57	0.09	1.88	0.23	0.51	0.03	0.07		92.50	0.06	0.91	
E	1700	1700				9780			1.07	0.56	0.09	1.88	0.22	0.52	0.03	0.06		92.50	0.06	0.92	
E	1650	1680				10100			1.08	0.56	0.09	1.88	0.22	0.52	0.03	0.07		92.50	0.06	0.92	
E	1710	1690				9910			1.08	0.56	0.09	1.88	0.23	0.52	0.03	0.07		92.50	0.06	0.93	
E	1820	1700				10100			1.08	0.56	0.09	1.88	0.23	0.52	0.03	0.06		92.50	0.06	0.92	
E	1660	1690				9900			1.08	0.57	0.09	1.87	0.23	0.53	0.03	0.06		92.50	0.07	0.91	
F		1880	1740					9900													
F		1730	1770					9300													
F		1680	1750					10300													
F		1730	1740					9700													
F		1610	1730					9900													
F		1720	1750					9900													
F		1710	1820					9800													
F		1750	1810					9900													
G			1700	1600	1600			9900	1.12	0.56	0.09	1.84	0.21	0.57	0.05	0.02	0.41	91.20	0.07	1.01	
G			1800	1600	1600			9900	1.11	0.56	0.09	1.92	0.22	0.57	0.04	0.02	0.42	91.20	0.07	1.14	
G			1700	1600	1600			9800	1.09	0.58	0.09	1.87	0.23	0.52	0.02	0.03	0.41	92.40	0.07	1.11	
G			1800	1600	1600			9900	1.22	0.59	0.09	1.86	0.24	0.52	0.03	0.04	0.42	92.50	0.07	1.14	
G			1700	1600	1600			9800	1.30	0.60	0.08	1.87	0.24	0.51	0.03	0.04	0.43	92.50	0.07	1.12	
G			1700	1600	1600			10000	1.15	0.55	0.10	1.86	0.22	0.56	0.05	0.03	0.40	91.80	0.07	1.03	
G			1600	1500	1500			9600	1.10	0.56	0.09	1.85	0.23	0.54	0.04	0.04	0.42	91.60	0.07	1.12	
G			1800	1600	1600			9900	1.08	0.57	0.08	1.87	0.23	0.53	0.04	0.04	0.42	91.80	0.07	1.08	
H		1644	1654			10438	10499														
H		1677	1640			10356	10515														
H		1673	1627			10477	10588														
H		1665	1630			10372	10549														
H		1669	1665			10455	10526														
H		1676	1647			10432	10362														
H		1659	1649			10483	10439														
H		1687	1633			10328	10489														
I		1700	1670	1600	1600	10100	10400	9600	1.10	0.57	0.08	1.88		0.57	0.04	0.10	0.41	91.60	0.07	1.06	2.75
I		1740	1710	1600	1600	10400	10300	9700	1.12	0.57	0.09	1.87		0.57	0.04	0.08	0.41	92.10	0.07	1.21	2.72
I		1700	1710	1500	1500	10300	10300	9500	1.09	0.56	0.12	1.82		0.57	0.03	0.07	0.41	91.00	0.07	1.08	2.74
I		1720	1670	1500	1500	10400	10200	9500	1.10	0.56	0.12	1.83		0.57	0.03	0.07	0.41	91.80	0.06	1.04	2.75
I		1730	1690	1500	1500	10400	10200	9700	1.12	0.57	0.10	1.85		0.57	0.03	0.07	0.41	91.60	0.06	1.06	2.71
I		1720	1730	1400	1400	9950	10300	9800	1.11	0.58	0.10	1.84		0.57	0.03	0.07	0.42	91.50	0.06	1.03	2.73
I		1750	1680	1500	1500	10300	10200	9600	1.12	0.58	0.09	1.86		0.57	0.03	0.07	0.41	92.00	0.06	1.04	2.73
I		1710	1690	1500	1500	10300	10200	9800	1.09	0.58	0.09	1.82		0.56	0.03	0.07	0.41	91.00	0.06	1.59	2.73
K		1600								0.64		1.82		0.40	0.03	0.06		91.49			
K		1700								0.65		1.73		0.38	0.03	0.06		91.22			
K		1700								0.67		1.64		0.43	0.03	0.06		91.23			
K		1600								0.59		1.70		0.35	0.03	0.06		91.00			
K		1700								0.62		1.70		0.38	0.03	0.08		91.94			
K		1700								0.66		1.69		0.36	0.03	0.07		92.31			
K		1700								0.67		1.76		0.40	0.03	0.07		91.23			
K		1700								0.63		1.67		0.38	0.03	0.07		92.13			
L		1600	1560	1640	1640	10600	10350	10350	1.12	0.56	0.09	1.86	0.23	0.52	0.03	0.05		92.50	0.08	0.90	
L		1570	1600	1640	1640	10400	10600	10300	1.12	0.57	0.08	1.85	0.23	0.52	0.03	0.04		92.60	0.08	0.91	
L		1560	1610	1640	1640	10250	10650	10250	1.12	0.56	0.09	1.84	0.23	0.51	0.03	0.05		92.60	0.07	0.90	
L		1520	1630	1660	1660	10150	10700	10300	1.13	0.55	0.08	1.84	0.22	0.51	0.03	0.05		92.60	0.07	0.91	
L		1600	1580	1680	1680	10650	10600	10450	1.13	0.56	0.09	1.86	0.22	0.52	0.03	0.05		92.50	0.07	0.91	
L		1610	1660	1640	1640	10650	11050	10200	1.12	0.56	0.09	1.84	0.23	0.52	0.03	0.05		92.60	0.07	0.90	
L		1600	1580	1660	1660	10350	10600	10150	1.12	0.55	0.09	1.83	0.22	0.51	0.03	0.05		92.60	0.07	0.92	
L		1590	1570	1650	1650	10550	10500	10200	1.12	0.55	0.09	1.84	0.22	0.52	0.03	0.04		92.60	0.07	0.91	
M		1680	1580			10450	9880		1.10	0.56	0.08	1.82	0.22	0.52	0.03			92.60	0.07	0.96	
M		1690	1630			10400	10100		1.10	0.55	0.08	1.81	0.22	0.52	0.03			92.70	0.08	0.91	
M		1710	1590			10750	9870		1.10	0.57	0.08	1.83	0.22	0.52	0.03			92.60	0.08	0.94	
M		1750	1620			10750	10050		1.10	0.56	0.09	1.84	0.22	0.54	0.03			92.50	0.09	0.92	
M		1720	1600			10600	9890		1.11	0.55	0.08	1.78	0.22	0.51	0.03			92.80	0.06	0.93	
M		1730	1620			10500	10050		1.11	0.56	0.08	1.81	0.22	0.51	0.03			92.70	0.07	0.93	
M		1690	1620			10500	10100		1.11	0.55	0.07	1.77	0.22	0.50	0.03			92.80	0.07	0.96	
M		1660	1660			10250	10250		1.11	0.56	0.08	1.79	0.22	0.51	0.03			92.70	0.07	0.93	
N	1560	1630	1630			10450	9980		1.12	0.55	0.09	1.83	0.23	0.59	0.03	0.10		93.02	0.07	1.02	2.77
N	1560	1580	1610			10450	9890		1.10	0.55	0.09	1.81	0.24	0.58	0.03	0.11		92.70	0.07	1.03	2.79
N	1550	1560	1660			10700	9830		1.11	0.54	0.09	1.83	0.23	0.59	0.04	0.10		92.85	0.07	1.05	2.73
N	1580	1580	1570			10450	9890		1.12	0.54	0.08	1.82	0.23	0.58	0.03	0.10		93.25	0.08	1.04	2.70
N	1560	1630	1570			10450	10250		1.09	0.54	0.08	1.80	0.23	0.57	0.03	0.10		92.89	0.08	1.07	2.67
N	1530	1660	1610			10450	10350		1.12	0.55	0.09	1.85	0.24	0.60	0.03	0.10		93.03	0.07	1.06	2.78
N	1540	1660	1550			10350	10400		1.10	0.54	0.09	1.82	0.24	0.58	0.03	0.10		92.85	0.08	1.04	2.79
N	1550	1670	1600			10500	10550		1.11	0.54	0.08	1.83	0.23	0.59	0.03	0.10		93.10	0.07	1.03	2.72
O	1600	1620	1600	1620	1620	10550	10300	10550	1.10	0.53	0.08	1.81	0.23	0.49	0.03	0.01	0.41	93.60	0.08	0.97	
O	1720	1610	1600	1610	1610	10250	10750	10350	1.10	0.54	0.08	1.79	0.23	0.49	0.03	0.01	0.41	93.30	0.09	0.80	
O	1660	1620	1620	1600	1600	10050	10550	10450	1.09	0.53	0.08	1.80	0.22	0.49	0.03	0.01	0.41	93.00	0.09	0.86	
O	1770	1600	1600	1600	1600	10150	10800	10300	1.10	0.53	0.08	1.80	0.22	0.50	0.03	0.00	0.41	93.30	0.08	0.82	
O	1750	1610	1570	1600	1600	10000	10250	10450	1.09	0.53	0.08	1.80	0.22	0.50	0.03	0.00	0.41	93.20	0.09	0.89	
O	1750	1630	1610	1630	1630	9980	10250	10650	1.10	0.54	0.08	1.80	0.22	0.50	0.03	0.01	0.41	93.30	0.08	0.80	
O	1710	1600	1590	1500	1500	9820	9960	10200	1.10	0.51	0.07	1.68	0.22	0.44	0.02		0.41	93.00	0.06	0.85	
O	1660	1610	1580	1610	1610	10150	10650	10800	1.11	0.55	0.08	1.78	0.22	0.46	0.03	0.01	0.41	92.80	0.07	0.87	

Assay data (cont)

Lab Code	Co F	Co M/ICP	Co P	Co XRF	Cu F	Cu M/ICP	Cu P	Cu XRF	Al2O3 XRF	CaO XRF	Cr2O3 XRF	Fe2O3 XRF	K2O XRF	MgO XRF	MnO XRF	Na2O XRF	P2O5 XRF	SiO2 XRF	TiO2 XRF	LOI	SG pyc
	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	
P	1780	1600	1600			10400	10200		1.14	0.63		2.13		0.56	0.03		0.40	98.60	0.07		2.78
P	1800	1610	1560			10450	9880		1.15	0.65		2.07		0.56	0.04		0.43	99.30	0.07		2.74
P	1790	1610	1500			10450	9460		1.14	0.63		2.04		0.56	0.03		0.42	98.70	0.07		2.73
P	1740	1630	1580			10450	9930		1.13	0.63		2.02		0.55	0.03		0.43	97.50	0.07		2.75
P	1780	1650	1580			10450	10000		1.14	0.65		2.03		0.56	0.03		0.42	98.40	0.07		2.74
P	1800	1590	1620			10450	10350		1.15	0.65		2.04		0.56	0.03		0.42	99.50	0.07		2.73
P	1760	1610	1580			10550	10100		1.13	0.65		2.02		0.55	0.03		0.45	97.90	0.07		2.75
P	1750	1620	1630			10350	10200		1.13	0.65		2.01		0.55	0.03		0.43	98.00	0.07		2.74
Q				1500	1500			9200													2.74
Q				1500	1500			9700													2.74
Q				1500	1500			9500													2.74
Q				1500	1500			9500													2.74
Q				1500	1500			9700													2.74
Q				1600	1600			9800													2.75
Q				1700	1700			9400													2.74
Q				1700	1700			9400													2.73
R	1634		1740	1670	1670		10356		1.12	0.55	0.09	1.88	0.23	0.51	0.03	0.04	0.41	92.43	0.07	0.90	2.64
R	1645		1697	1675	1675		10016		1.11	0.56	0.09	1.89	0.23	0.52	0.03	0.04	0.42	92.56	0.07	0.92	2.65
R	1648		1666	1656	1656		10017		1.09	0.54	0.09	1.88	0.22	0.51	0.03	0.03	0.41	92.07	0.07	0.92	2.69
R	1632		1641	1651	1651		9884		1.12	0.55	0.09	1.89	0.23	0.51	0.03	0.04	0.42	91.98	0.07	0.92	2.68
R	1634		1777	1678	1678		10356		1.10	0.55	0.09	1.89	0.23	0.53	0.03	0.04	0.42	92.63	0.07	0.91	2.63
R	1655		1697	1675	1675		9984		1.11	0.55	0.09	1.89	0.23	0.52	0.03	0.04	0.42	92.68	0.07	0.88	2.71
R	1593		1667	1672	1672		9930		1.09	0.55	0.09	1.88	0.23	0.50	0.03	0.04	0.42	92.28	0.07	0.91	2.71
R	1650		1654	1667	1667		9841		1.09	0.56	0.09	1.89	0.24	0.52	0.03	0.03	0.41	92.91	0.07	0.92	2.75
U		1692				10578															
U		1658				10512															
U		1677				10607															
U		1673				10572															
U		1673				10576															
U		1691				10583															
U		1666				10596															
U		1645				10561															

12. Measurement of Uncertainty: The samples used in the certification process were selected in such a way as to represent the entire batch of material and were taken from the final packaged units; therefore all possible sources of uncertainty (sample uncertainty and measurement uncertainty) are included in the final combined standard uncertainty determination.

The uncertainty measurement takes into consideration the between lab and the within lab variances and is calculated from the square roots of the variances of these components using the formula:

Combined standard uncertainty=sqrt((between lab.var/no of labs) + (mean square within lab.var /no of assays))

These uncertainty measurements may be used, by laboratories, as a component for calculating the total uncertainty for method validation according to the relevant ISO guidelines.

Analyte	Method	Unit	S [1]	σ_L [2]	Sw [3]	CSU [4]
Co	F	ppm	56.18	46.77	38.14	18.41
Co	M/ICP	ppm	48.67	31.45	25.59	8.77
Co	P	ppm	54.56	40.03	28.29	12.47
Co	XRF	ppm	76.46	62.57	41.95	21.45
Cu	F	%	466.3	428.9	226.4	154.3
Cu	M/ICP	%	187.7	112.8	133.9	37.1
Cu	P	%	267.3	176.6	197.2	63.4
Cu	XRF	%	307.7	269.3	133.6	91.2
Al2O3	XRF	%	0.019	0.012	0.012	0.004
CaO	XRF	%	0.011	0.008	0.007	0.003
Cr2O3	XRF	%	0.006	0.004	0.004	0.001
Fe2O3	XRF	%	0.029	0.021	0.014	0.006
K2O	XRF	%	0.006	0.003	0.004	0.001
MgO	XRF	%	0.026	0.019	0.011	0.005
MnO	XRF	%	0.001	0.001	0.001	0.000
Na2O	XRF	%	0.015	0.013	0.005	0.004
P2O5	XRF	%	0.008	0.005	0.006	0.002
SiO2	XRF	%	0.401	0.257	0.224	0.075
TiO2	XRF	%	0.006	0.003	0.005	0.001
LOI		%	0.084	0.069	0.030	0.021
SG	pyc		0.027	0.016	0.021	0.006

1. *S - Std Dev for use on control charts.*
2. *σ_L - Betw Lab Std Dev, for use to calculate a measure of accuracy.*
3. *Sw - Within Lab Stc Dev, for use to calculate a measure of precision.*
4. *CSU - Combined Standard Uncertainty, a component for use to calculate the total uncertainty in method validation.*

13. Certified values: The Certified, Provisional and Informational values listed on p1 and p2 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Dr Barry Smee.

14. Metrological Traceability: The values quoted herein are based on the consensus values derived from statistical analysis of the data from an inter laboratory measurement program. Traceability to SI units is via the standards used by the individual laboratories, the majority of which are accredited, who have maintained measurement traceability during the analytical process.

15. Certification: AMIS0159 is a new material.

16. Period of validity: The certified values are valid for this product, while still sealed in its original packaging, until notification to the contrary. The stability of the material will be subject to continuous testing for the duration of the inventory. Should product stability become an issue, all customers will be notified and notification to that effect will be placed on the www.amis.co.za website.

17. Minimum sample size: The majority of laboratories reporting used a 0.5g sample size for the ICP. This is the recommended minimum sample size for the use of this material.

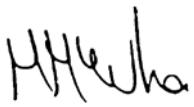
18. Availability: This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, vacuum sealed in foil pouches.

19. Recommended use: The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods, notwithstanding the underlying assumption that what the good inter-laboratory labs reported was accurate. However an amount of bad data might have had an effect, resulting in limits which in some situations might be too broad for the effective monitoring of a single analytical method, laboratory or production process. Users should set their own limits based on their own data quality objectives and control measurements, after determining the performance characteristics of their own particular method, using a minimum of 20 analyses using this CRM. User set limits should normally be within the limits recommended on p1 and 2 of this certificate.

20. Legal Notice: This certificate and the reference material described in it have been prepared with due care and attention. However AMIS, Set Point Technology (Pty) Ltd, Mike McWha, Dr Barry Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

14 July 2010

Certifying Officers:



African Mineral Standards:_____

Mike McWha
BSc (Hons), FGSSA, MAusIMM, Pr.Sci.Nat

Geochemist:_____

Barry W. Smee
BSc, PhD, P.Geo, (B.C.)

Appendix 1. – Uncertified trace element statistics

Eight of the laboratories submitted significant total digestion / multi element scan trace element data and four laboratories submitted additional Co and Cu methods. This data has been compiled and iterated but not certified. It is presented below for informational use.

Analyte	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	%	0.58	0.06	4.9	60
As	M/ICP	ppm	5.50	1.49	13.6	44
Ba	M/ICP	ppm	45.0	7.14	7.9	62
Be	M/ICP	ppm	0.60	0.000	0.0	21
Bi	M/ICP	ppm	2.69	0.13	2.4	16
Ca	M/ICP	%	0.41	0.05	6.0	62
Cd	M/ICP	ppm	0.13	0.09	37.0	8
Ce	M/ICP	ppm	8.44	1.74	10.3	23
Co	3 acid	%	0.168	0.019	5.7	46
Co	Sol	%	0.147	0.023	7.7	23
Cr	M/ICP	ppm	439	229	26.1	54
Cs	M/ICP	ppm	0.23	0.06	13.6	16
Cu	3 Acid	%	1.042	0.043	2.1	46
Cu	Sol	%	0.959	0.092	4.8	32
Cu	QLT	%	1.005	0.101	5.0	38
Dy	M/ICP	ppm	0.78	0.05	3.4	15
Er	M/ICP	ppm	0.55	0.07	6.5	16
Eu	M/ICP	ppm	0.16	0.02	6.4	15
Fe	M/ICP	ppm	1.34	0.12	4.3	60
Ga	M/ICP	ppm	1.70	0.15	4.3	16
Gd	M/ICP	ppm	0.92	0.15	8.3	16
Ho	M/ICP	ppm	0.16	0.000	0.0	14
In	M/ICP	ppm	0.03	0.01	20.0	14
K	M/ICP	%	0.19	0.02	5.2	54
La	M/ICP	ppm	4.79	0.75	7.8	40
Li	M/ICP	ppm	19.0	2.14	5.6	62
Lu	M/ICP	ppm	0.11	0.01	6.4	16
Mg	M/ICP	%	0.31	0.05	7.8	71
Mn	M/ICP	ppm	271	32.8	6.0	71
Mo	M/ICP	ppm	3.49	0.90	13.0	45
Na	M/ICP	%	0.04	0.01	12.6	56
Nb	M/ICP	ppm	0.75	0.43	28.9	8
Nd	M/ICP	ppm	3.86	0.11	1.4	15
Ni	M/ICP	ppm	62.1	11.3	9.1	94
P	M/ICP	%	0.19	0.02	5.2	47
Pb	M/ICP	ppm	12.2	3.61	14.8	55
Pr	M/ICP	ppm	1.03	0.10	4.6	16
Rb	M/ICP	ppm	7.93	0.35	2.2	16
S	M/ICP	%	0.03	0.01	17.7	39
Sb	M/ICP	ppm	2.65	2.66	50.2	21
Sc	M/ICP	ppm	1.94	0.16	4.2	47
Si	M/ICP	%	43.1	0.32	0.4	8
Sm	M/ICP	ppm	0.94	0.07	3.5	15
Sn	M/ICP	ppm	1.31	0.62	23.5	14
Sr	M/ICP	ppm	26.6	2.73	5.1	61
Tb	M/ICP	ppm	0.13	0.02	6.2	16
Th	M/ICP	ppm	1.77	0.57	16.1	16
Ti	M/ICP	%	0.03	0.01	16.8	48
Tm	M/ICP	ppm	0.09	0.02	9.7	16
U	M/ICP	ppm	63.4	3.84	3.0	16
V	M/ICP	ppm	30.3	1.90	3.1	55
W	M/ICP	ppm	0.47	0.12	13.2	15
Y	M/ICP	ppm	4.59	0.62	6.7	35
Yb	M/ICP	ppm	0.71	0.07	4.8	16
Zn	M/ICP	ppm	70.2	13.6	9.7	79
Zr	M/ICP	ppm	18.5	13.8	37.3	48